SECRET

[redacted] 25X1

Copy 11 of 12

20 September 1962

MEMORANDUM FOR : Chief, Development Division, OSA-DD/R

SUBJECT : Summary - OXCART Engine Program Review, Attached

1. Continuous Mach 3.2 flight suitability substantiation is not expected until December 1962. Limited excursions to Mach 3.2 may be possible before then.

2. Preliminary performance data indicates a 3 to 10% thrust deficiency at altitude.

3. Fourteen instead of sixteen engines are expected to be delivered by 31 December 1962.

4. Difficulties in converting successful Mach 3.2 development hardware into production hardware are pacing main fuel control and hydraulic pump deliveries and jeopardizing engine deliveries.

5. Two 50 hour engine endurance tests were completed recently, one at sea level the other at Mach 3.2 inlet conditions.

6. Sufficient AR additive is on order for initial flight test through December 1962.

[redacted] 25X1
Development Division
OSA-DD/R

Attachment:

25X1 [redacted] dtd 20 September 1962

25X1 DD/OSA, [redacted]

Distribution:
1&2-DD/R
3-AD/SA
4-C/DD/OSA
5&6-DD/OSA
7-TAES/OSA
8-C/MD/OSA
25X1 9-[redacted]
10-AFCIC-5
11-RB/OSA
12-DD (Chrono)

25X1

SECRET

[redacted]

SECRET

25X1

Copy 1 of 12

20 September 1962

MEMORANDUM FOR : The Record

SUBJECT : OXCART Engine Program Review

REFERENCE : (a) [redacted] dated 6 August 1962, titled "Current Developments - OXCART Engine Program" 25X1

(b) [redacted] dated 23 July 1962, titled "Recent Significant Developments - OXCART Engine Program" 25X1

(c) [redacted] dated 21 June 1962, titled "Status - OXCART Engine Program" 25X1

1. This report describes significant highlights of subject program since the release of reference memoranda as surfaced during recent visits to Pratt & Whitney Florida, Pratt & Whitney Hartford, [redacted] 25X1 25X1

2. Major Problem Areas:

Several of the current major problem areas are summarized as follows:

(a) Continuous Engine Durability at Mach 3.2:

Although considerable progress toward the Mach 3.2 continuous rating is currently evident, completion of this qualification is not expected until December 1962. Major contributions to this slippage have been made by the diversion of design, development and test effort expended in the crash incorporation of the so called Phase I plumbing changes into initial delivery engines as described in reference (a) and (b) memoranda and by a slower more cautious accumulation of high Mach number test time brought about by a turbine failure during the summer as described in refekence (a) memorandum.

With the recent successful demonstration of sea level engine test durability of the Phase I plumbing changes, Mach 3.2 bench durability of the main fuel control, and engine test durability of the main fuel control and the E configuration hydraulic pump at 300° fuel inlet temperature the remaining outstanding prerequisites for Mach 3.2 engine qualification are: [redacted] 25X1

SECRET

(1) Further confirmation of afterburner durability and performance is required. Sea level durability of a 28,000 lb. thrust afterburner has been demonstrated while separately a 30,000 lb. sea level thrust performance capability has been demonstrated. Durability of the 30,000 lbs. configuration has not been demonstrated, nor has durability or performance at altitude been fully demonstrated for either configuration.

(2) Further evaluation of main burner can durability at altitude and high Mach number is required. Although preliminary inspection of cans from engine FX-112 after a 50 hour test at Mach 3.2 inlet temperature reveals very little coking and no indication of overheating, past experience at high altitude and Mach number has revealed much coking and overheating as described in reference (a) and (c) memoranda.

(3) Very little testing has been conducted with the engine completely enclosed in the Mach 3.2 environmental temperatures of 800°F. Engine, facility, and personnel safety is a concern sure to bear upon the cautious approach to this condition.

The recent successful completion of a 50 hour Mach 3.2 mission inlet temperature test by engine FX-112 has been most encouraging. Engine FX-115 is now mounting in the C-4 altitude stand for a completely shrouded Mach 3.2 mission cycle endurance test at environmental temperatures for a complete engine evaluation including the above prerequisites.

(b) Engine Performance:

Current performance test data indicates a 3 to 10% thrust deficiency at Mach 3.2 cruise and 76,000 ft. altitude. The seemingly wide variation of from 3 to 10% is due to the tolerance build-up involved in the relatively complex method of gross thrust determination under altitude and ram conditions. The deficiency itself is felt by the contractor to be due to the various gas path compromises made during the past year for establishing compressor, combustion section, turbine, and afterburner durability. Three development engines plus compressor and burner rigs are currently assigned to performance evaluation and development. The significance of this problem while not affecting durability lies in its impact upon the mission profile.

(c) Engine Deliveries:

Because of the impact felt by the incorporation into initial delivery engines of the Phase I plumbing changes and because of pacing main fuel control deliveries, the currently promised total of six engines delivered by 30 September is questionable. A realistic appraisal of the situation to be expanded in a subsequent paragraph indicates the probability of four engines delivered with a remotely possible fifth by 30 September.

25X1

SECRET

3. Delivery Status:

(a) Current delivery engine status with estimated target dates is as follows:

Engine	YD-3	Delivered	21 August
	YD-2	Delivered	4 September
	YD-1	On final test at Hartford, targeting delivery 22 September.	
	YD-4	In final build at Hartford, targeting final test 21 September, targeting delivery 27 September.	
	YD-5	Inspection after green test, targeting final test 26 September, targeting delivery 1 October.	
	YD-6	In green build, targeting green test 21 September, targeting final test on crash basis 5 October, targeting delivery 10 October earliest.	

Appraisal of the above status indicates that YD-6 and probably YD-5 will be delivered in October.

(b) A comparison of current engine contractor delivery promises with a DD/OSA reappraisal based upon the above status is as follows:

	Engine Delivery Promise	DD/OSA Reappraisal
Aug	2/2	1/1
Sept	4/6	3/4
Oct	3/9	3/7
Nov	3/12	3/10
Dec	4/16	4/14

The reason that the two engines dropped in August and September may not be regained by December is because of a turbine exhaust case and number two bearing support shortage anticipated during October and November. Inability of the vendor to maintain delivery of these two weldments has resulted in transfer of these jobs into the contractor's plant at Hartford scheduled to take place in October.

(c) Delivery, return, and re-delivery of main fuel controls which has paced the delivery of engines YD-1 and YD-4 and may pace engines YD-5 and YD-6 is again expected by the contractor to improve sufficiently after October so as to no longer be pacing. Engineering change impact, casting quality, calibration difficulties with the first Mach 3.2 control, and insufficient repeatable accuracy after calibration have contributed to this deficiency. In addition to expected improvement in the above factors, enough units should be in process by November so that

SECRET

backups will be available for replacing faulty units as contingencies arise.

Delivery of hydraulic pumps which so far has not paced engine deliveries might become pacing if difficulty continues on the part of [redacted] to convert successful development hardware into deliverable production hardware. The trouble appeared to lie in the areas of sufficient historical record control and identification of development and production hardware and in the establishment and execution of appropriate production process specifications. [redacted] was asked to review and tighten all appropriate process specifications and to review and rewrite all standard practice instructions governing the flow of production hardware from procurement through final test. A copy of the rewritten standard practice instructions which is reportedly in effect now has been received by DD/OSA.

Compatibility between engine delivery promises and component delivery latest revision promises is as follows:

	Eng. Delivery Promises	Main Fuel Control Delivery Promises	Hydraulic Pump Delivery Promises
Aug	2/2	2/2*	3/6**
Sept	4/6	5/7	5/11
Oct	3/9	7/14	11/22
Nov	3/12	7/21	6/28
Dec	4/16	7/23	6/34

*On 9 August a total of 11 production controls had been delivered of which 5 were assigned to delivery engines at Hartford and 6 were assigned to development in Florida. Of the 5 delivered to Hartford, 3 were returned for inaccuracy leaving a balance of only two until 7 September. At present a total of 4 controls are delivered to delivery engines.

**At present a total of 6 hydraulic pumps are delivered to delivery engines.

(d) Reported field problem areas which have or may affect engine/airframe installation are briefly listed as follows for record purposes. Investigation and/or corrective actions are underway.

(1) Incorporation of engine Phase I plumbing changes.
(2) Engine remote gearbox system change.
(3) Engine control instability and sensitivity to installation.
(4) Engine turbine inlet temperature thermocouple short life.
(5) Engine afterburner nozzle gas seal.
(6) Airframe starter cart marginal output.
(7) Airesearch TMC-105 starter cart output.

[redacted]

(6) Airframe quick engine change (QEC) kit shortage for engine YD-2.
(9) Airframe requested engine mount change effective for engine YD-4.

4. Development Status:

(a) Two 50 hour engine tests were completed during the past month bringing the total to six 50 hour tests completed since September 1961. One of these tests comprised a sea level afterburning endurance while the other comprised a Mach 3.2 mission cycle inlet temperature endurance. Significance of the sea level test in addition to establishing repeatable sea level gas generator and component durability lies in the initial establishment of afterburner and plumbing durability (including the Phase I changes excepting the afterburner fuel manifold coupling which has been demonstrated separately). Significance of the Mach 3.2 test lies in the initial apparent gas generator and engine mounted component durability at high Mach number inlet air and fuel conditions. Final tear down inspection of the latter test engine is incomplete. A brief summary of reported inspection results for the sea level test and preliminary findings for the Mach 3.2 test is listed on Attachment 1.

(b) Major development problems have been covered in paragraph 2. Expanding upon the first problem area cited, that of continuous engine durability at Mach 3.2, it is appropriate here to say that since the completion of the first Mach 3.2 test cited above, the contractor feels with the accumulation of some flight test experience with initial delivery engines and with some further ground test evaluation of altitude afterburner and shrouded engine durability limited flight excursions into the Mach 3 regime may be permissible before December 1962.

(c) Engine test time accumulation during the past month is as follows:

	14 Aug	14 Sept	Increase
Total Engine Hours	4433	4819	386
J71ID-20 Engine Hours	1586	1968	382
Hours Above Mach 2	280	325	45
Hours At Or Above Mach 3	42	87	45
Hours With Automatic Controls	519	766	247

Present engine activity is shown on Attachment 2.

[redacted] 25X1

25X1

SECRET

SECRET

[redacted] 25X1

[redacted] 25X1

[redacted] 25X1

Development Division
OSA-DD/R

25X1 DD/OSA/[redacted]
Distribution:
1&2-DD/R
3-AD/SA
4-C/DD/OSA
5&6-DD/OSA
7-TAES/OSA
8-C/MD/OSA
25X1 9-[redacted]
10-AFCIC-5
11-EB/OSA
12-DD (Chrono)

[redacted] 25X1

SECRET

SECRET

Attachment 1

25X1

Summary - Preliminary 50 Hour Test Results
August and September 1962

	Engine XD-3 Sea Level Afterburning Mission Endurance	Engine FX-112 Mach 3.2 Non Afterburning Mission Endurance
Time Breakdown (Hours)		
Total this build	95	82
Endurance cycle	60	60
Afterburning	40	0
Maximum 1900°F Turbine Temperature	40	40
Mach 3.2 inlet temperature	0	40
With automatic controls	95	82
Summary Preliminary Visual Inspection Findings:	As reported by the contractor.	As reported by the contractor and as seen by the writer during initial tear-down in process 14 September.
1. Compressor	Condition good.	Only 9th stage was visible; appeared good. Reports that honeycomb at front end indicating rub due to two emergency shutdowns.
2. Main Fuel Nozzles	Slight coking - generally good.	Not visible - reportedly good.
3. Diffuser Case	Condition good.	Not visible - reportedly good.
4. Main Burner Cans	Slight coking - good.	Very slight coking - good.
5. Transition Duct - Hot Gas Path to Turbine	Condition good.	Not visible - reportedly good.
6. Turbine Inlet Temperature Thermocouple Housings	Condition good.	Not visible - reportedly good.
7. Turbine Blades and Vanes	Good - even heat distribution.	Blades appeared excellent. Vanes appeared good - [redacted]on.

25X1

SECRET

	XD-3	FX-112
8. Afterburner	Condition good. Liners intact without distress, spraybars not plugged nor coked.	Not tested.
9. Plumbing	All bill of material piping including Phase I changes - condition good. No leaks, no replacements. Afterburner coupling fix not tested on this engine.	Replaced leaking hydraulic system filter and engine lube pump during test. All bill of material piping - conditi good, no leaks, no replacements.
10. Controls	Good - fully automatic without adjustment throughout test. Burner pressure probe evidenced some plugging.	Good - fully automatic without adjustment throughout test.
11. Chemical Ignition Unit	Condition and operation good.	Operation reportedly good.
12. Hydraulic Pump	E configuration pump operation good throughout test. Used 3% oil additive with cold fuel.	E configuration pump operation good throughout test. Used 300°F max. temperature fuel per mission cycle without oil additive and without high ambient temperature.
13. Main Bearings	Good	Reportedly good.
14. Accessory Drive System	Main engine gearbox condition good. Replaced reduction gearbox at 13 hours due bearing failure attributed to faulty installation. Replaced remote gearbox on pre-test calibration due leakage of internal breather tube.	Not tested.

25X1

Attachment 2

[redacted]

25X1

Development Engine Status

Engine Number	Program	Status
FX-111	Turbine performance	On test
FX-112	Mach 3.2 endurance	Teardown
FX-113	Performance (Millgoes)	On test
FX-114	Afterburner Development	Rebuild
FX-115	Mach 3.2 endurance	*Mounting
FX-116	New engine	Build
FX-117	Afterburner Development	On test
FX-118	Control system stability	On test
XD-1	Mach 3 afterburner performance	On test
XD-2	Performance	Rebuild
XD-3	Endurance	Rebuild

*C-4 stand - new altitude facility targeted for November completion - now in final checkout.

25X1

[redacted]